Progress Report, 2006

Canebrake Ecosystem Restoration

respectfully submitted to

Dahomey National Wildlife Refuge

by

Scott B. Franklin & Margaret C. Cirtain
May 4, 2007

PURPOSE OF RESEARCH

The *Arundinaria gigantea* (Walt.) Muhl. canebrake ecosystem, once a dominant landscape component of the southeastern United States, is now reduced to less than two percent of its former area (Noss et al, 1995). Currently it is restricted to fragmented populations, most commonly found along stream banks, fence rows, and edges of agricultural fields and forests. Fragmented populations have been limited in growth due to increasing agricultural and urban development and encroaching closed canopy forests.

A decline in the *A. gigantea* population has resulted in a critically endangered ecosystem with a loss of species diversity and ecosystem services (Remson 1986, Conover 1994, Judziewicz et al. 1999, Brantley and Platt 2001, Platt et al. 2001). Swainson's Warbler (*Limnothlypis swainsonii*), now placed on the Audubon watch list (Graves 2001), and the extinct Bachman's Warbler are avian species often associated with this decline (Brawn et al., 2001). Other species are now approaching extinction or have become extinct. An example is the Creole Pearly Eye (*Enodia creola)*, which uses river cane as its host plant, and considered uncommon to rare throughout its range. Additional species were known to utilize the canebrake habitat, including a number of mammalian species like swamp rabbit, cougar, and black bear. However, information is limited to historical references as research of this diminished ecosystem is lacking (Thomas et al. 1996). Reestablishment of canebrakes is necessary for maintaining and enhancing biodiversity in the southeastern United States and for providing areas for study of this unique and poorly understood ecosystem.

Additionally, canebrakes may have contributed significantly to ecosystem services such as erosion control and improving water quality. Cane, with its extensive rhizomal system, has been considered for streambank and roadway embankment stabilization (Dattilo and Rhoades, 2005; Zaczek et al., 2004). Agricultural sediment and nutrients can be reduced using giant cane buffer strips improving water quality in riparian restoration projects (Schoonover et al., 2006). However, information on this once dominant ecosystem, which covered thousands of acres in the southeastern United States (Brantley and Platt, 2001; Platt and Brantley, 1997), is lacking, with little known of the physiology of the species and canebrake ecosystem function.

Historical accounts of canebrakes suggest that they were widespread on floodplains and stream terraces (moist soils, but not inundated for long periods of time) throughout the southeastern United States and tolerated a variety of environmental conditions (Caplenor 1968, Gilliam and Christensen 1986, Baskin et al. 1997, Nelson 1997, Platt and Brantley 1997, Fickle

2001, Fralish and Franklin 2002). However most of the canebrake habitat has been lost due to lack of fire disturbance, replacement by cultivated fields, or use as domestic livestock feed (Hughes 1966, Platt and Brantley 1997). Thus, the current distribution of cane does not necessarily imply its physiological or ecological tolerances for certain environmental conditions. One hint may be the tendency for cane to grow along edges of forests, suggesting cane is intolerant of shade and perhaps other competition.

Previous studies suggest light may be a limiting factor for cane growth (Cirtain et al., 2003), but there remains a lack of knowledge of river cane's physiological requirement for light. River cane remnant populations are often found in forest understories. Shading reduces the plants ability to carry out photosynthetic processes by reducing the level of radiant energy. Solar radiation supplies the energy for metabolism and maintains plant temperature. The fitness success of a plant, in this case, vegetative propagation, depends upon photosynthesis to meet metabolic requirements. Forest canopy impacts understory flora by influencing the irradiance, the distribution of the understory, and periodicity, especially seasonal effects (Fitter and Hay, 2002). Life history characteristics of cane (evergreen, clonal aspect, and rhizome nutrient storage) and community structure (canopy gap patterns and size) may play important roles in canebrake persistence and prove critical for reestablishment.

The goal of this study is to facilitate reestablishment of *A. gigantea* canebrakes by examining environmental parameters critical to establishment (competition, light levels, soil moisture and nutrients). Field studies using transplants have been developed to determine conditions necessary for establishment and growth. We hypothesized that 1) *A. gigantea* would have greater numbers of new shoots and greater growth (height) of new shoots when competition was controlled and 2) when fertilizer was applied. The third experiment tests the hypothesis that cane growth is limited by shading under full canopy forests. We hypothesized 3) new shoot numbers and growth would increase following canopy thinning.

Competition Experiment

Methods

A site of *Arundinaria gigantea* was established at Dahomey National Wildlife Refuge with eight plots. Each plot consists of sixteen plantings in a four by four array. Treatments were untreated controls and treated with an application of landscape fabric and hay mulch around the plantings. Measurements were taken on new shoot height (meter), new shoot diameter (millimeter), new shoot number, and survival.

Analysis

For survival, plantings within the treatment site were counted for analyses as either living, or dead. Total number of new stems, stem diameters, and stem heights were averaged for each treatment plot prior to analyses. A repeated measures analysis of variance (ANOVA) (DNWR: n=4) was performed for each hypothesis: 1) there was no change in the relative percentages of survival following application of the landscape fabric, 2) there was no change in the relative number of new shoots following application, and 3) there was no difference in stem diameter or stem height for three growing seasons following application.

Results & Interpretation

Hypothesis 1: There was no change in the relative percentages of survival following application of the landscape fabric to plots.

We found no significant difference between the percentage of survival in the control group when compared to the treatment group at DNWR (Table 1; Figure 1), suggesting no competitive effect on transplant survival.

Hypothesis 2: There was no change in the relative number of new shoots following application of landscape fabric.

We found no significant difference in the total number of new shoots in the control group when compared to the treatment group at DNWR (Table 1; Figure 2). Additionally, when competition results were compared in 2003, (results were based on plants within plots and therefore not comparable to 2004 plot-based results) results at DNWR did not show a significant difference, suggesting competition is not an important factor in cane establishment.

Hypothesis 3: There was no difference in stem diameter or stem height following application of landscape fabric.

We found no significant difference in the total new shoot diameter, and no significant difference in total new shoot height in the control group compared to the treatment group at DNWR (Table 1; Figure 3 and 4). These results suggest there was no effect of landscape fabric application treatment which did not support our hypothesis.

Figure 1. Percent survival comparison between control and landscape fabric application plots at Dahomey National Wildlife Refuge.

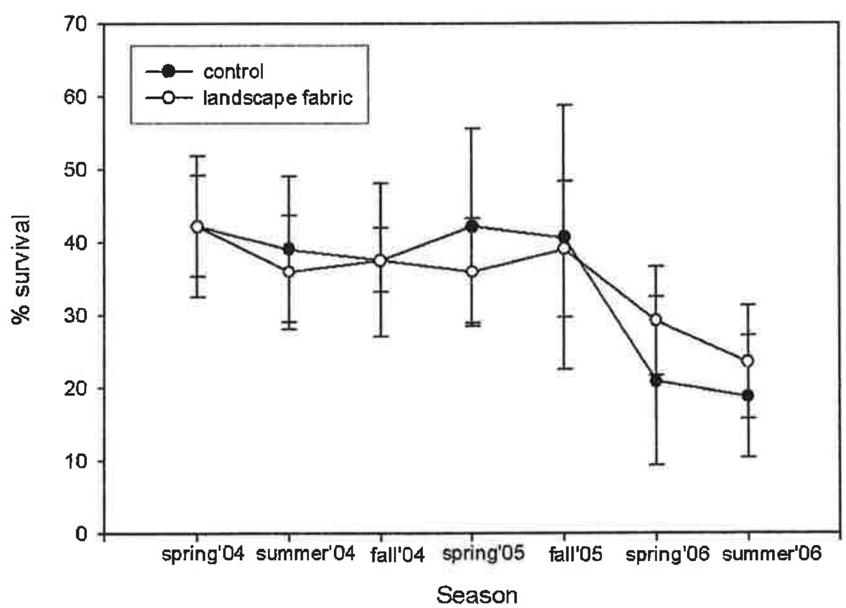


Figure 2. Total new shoot number comparison between control and landscape fabric application plots at Dahomey National Wildlife Refuge.

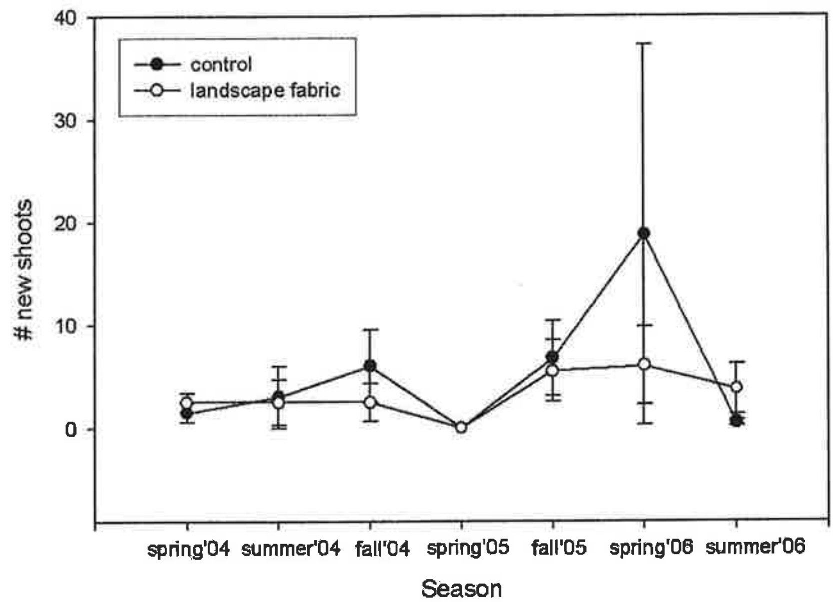


Figure 3. Total new shoot height (m) comparison between control and landscape fabric application plots at Dahomey National Wildlife Refuge.

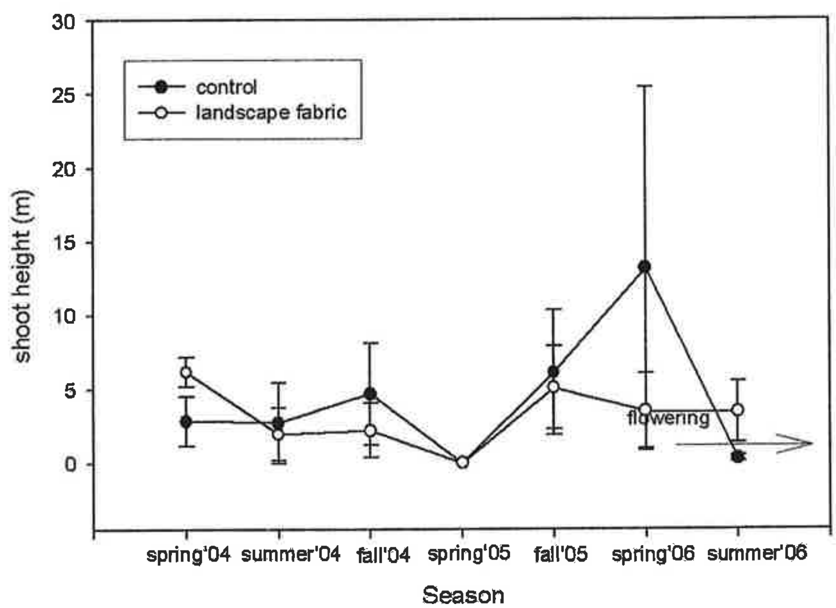


Figure 4. Total new shoot diameter (mm) comparison between control and landscape fabric application plots at Dahomey National Wildlife Refuge.

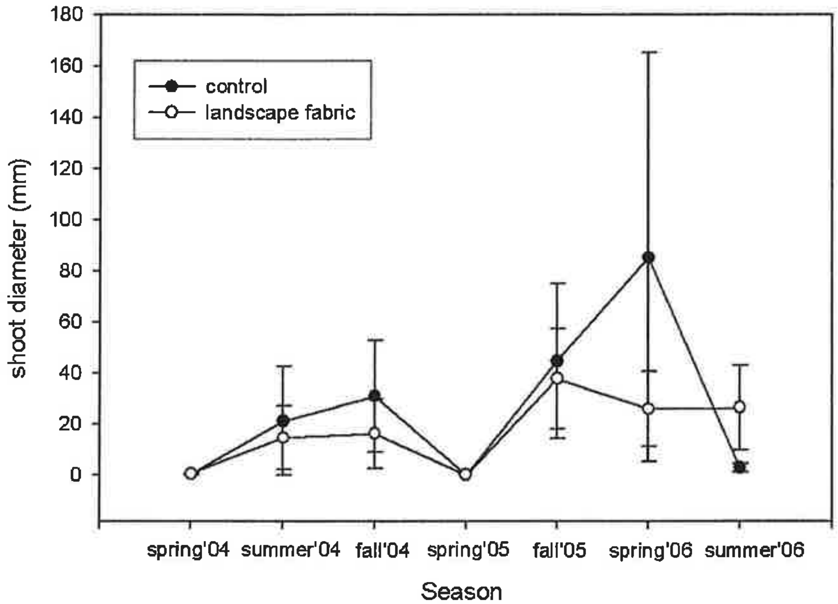


Table 1. Results of repeated measures ANOVA statistical analysis comparing % survival, number of new shoots, new shoot diameter (mm), new shoot height (m) of control plants to plants treated with a landscape fabric application.

Variable	Treatment(n=4)	Time	Mean	Std error	F	p
% Survival	Control	Spring '04	42.1875	9.67405	0.000	1.000
		Summer '04	39.0625	10.00488	0.061	0.814
		Fall '04	37.5000	10.52032	0.000	1.000
		Spring '05	42.1875	13.35001	0.168	0.696
		Fall '05	40.6250	18.13218	0.006	0.941
		Spring '06	20.8333	11.59951	0.364	0.579
		Summer '06	18.7500	8.46254	0.166	0.698
	Land Fabric	Spring '04	42.1875	6.92924		
		Summer '04	35.9375	7.81250		
		Fall '04	37.5000	4.41942		
		Spring '05	35.9375	7.38409		
		Fall '05	39.0625	9.33150		
		Spring '06	29.1667	7.51157		
		Summer '06	23.4375	7.81250		
Total ns #	Control	Spring '04	1.5000	0.95743	0.600	0.468
		Summer '04	3.0000	3.00000	0.018	0.897
		Fall '04	6.0000	3.55903	0.762	0.416
		Spring '05	0.0000	0.00000	0.000	0.000
		Fall '05	6.7500	3.61421	0.072	0.798
		Spring '06	18.7500	18.41817	0.460	0.523
		Summer '06	0.5000	0.28868	1.817	0.226
	Land Fabric	Spring '04	2.5000	0.86603		
		Summer '04	2.5000	2.17945		
		Fall '04	2.5000	1.84842		
		Spring '05	0.0000	0.00000		

		Fall '05	5.5000	2.95804		
		Spring '06	6.0000	3.76386		
		Summer '06	3.7600	2.39357		
Total ns dia(mm)	Control	Spring '04	0.4100	0.28080	0.228	0.650
		Summer '04	21.2150	21.21500	0.071	0.799
		Fall '04	30.9575	21.92508	0.336	0.583
		Spring '05	0.0000	0.00000	0.000	0.000
		Fall '05	44.7425	30.28801	0.038	0.852
		Spring '06	85.1700	79.92569	0.530	0.494
		Summer '06	2.7900	1.61143	2.025	0.205
	Land Fabric	Spring '04	0.5875	0.24315		
		Summer '04	14.6600	12.56880		
		Fall '04	16.2825	12.65990		
		Spring '05	0.0000	0.00000		
		Fall '05	37.7275	19.49910		
		Spring '06	25.9925	14.82565		
		Summer '06	26.5175	16.59505		
Total ns height (m)	Control	Spring '04	2.8725	1.67858	2.847	0.143
		Summer '04	2.7350	2.73500	0.058	0.818
		Fall '04	4.6875	3.41332	0.408	0.547
		Spring '05	0.0000	0.00000	0.000	0.000
		Fall '05	6.0925	4.22095	0.042	0.845
		Spring '06	13.1450	12.30968	0.590	0.472
		Summer '06	0.3100	0.17972	2.232	0.186
	Land Fabric	Spring '04	6.1725	1.00395		
		Summer '04	1.9525	1.74882		
		Fall '04	2.2125	1.83451		
		Spring '05	0.0000	0.00000		
		Fall '05	5.0575	2.79142		
		Spring '06	3.4925	2.54571		
		Summer '06	3.4225	2.07545		

Nutrient Experiment

Methods

A site was established Feb2004 at Dahomey National Wildlife Refuge (DNWR) and contained two treatments, one control and one with fertilizer applied (Osmacote); DNWR application started 10May04. There were ten plots (n=5) established at the Dahomey site. Sixteen plants were placed in each plot. Plants were allowed to establish approximately ten weeks prior to treatment.

Analysis

For survival, plantings within each treatment site were counted for analyses as either living, or dead. Total number of new stems, stem diameters, and stem heights were averaged for each plot at each treatment site prior to analyses. A repeated measures analysis of variance (ANOVA) (DNWR: n=5) was performed for each hypothesis: 1) There was no difference in the relative percentages of survival of existing culms following application of the fertilizer, 2) there was no difference in the total number of new shoots following application, and 3) there was no difference in stem diameter or stem height for two growing seasons following application.

Results & Interpretation

Hypothesis 1: There was no change in the relative percentages of survival of existing culms following application of the fertilizer.

We found no significant difference between the percentage of survival in the control group when compared to the treatment group at DNWR (Table 2 and Figure 5), albeit trend was slightly better survival with fertilizer application.

Hypothesis 2: There was no change in the relative number of new shoots following treatment.

We found no significant difference between the total number of new shoots in the control group when compared to the treatment group at DNWR (Table 2 and Figure 6), albeit the trend was slightly better growth with fertilizer treatment.

Hypothesis 3: There was no difference in stem diameter or stem height for two growing seasons following application

We found no significant difference between new shoot stem diameter or new shoot stem height in the control group when compared to the treatment group at DNWR (Table 2 and Figure 7 and 8). Both of these variables followed the same pattern as seen with the total number of new shoots; again, with no statistical significance. Again, the trend was better growth with fertilizer treatment.

Figure 5. Percent survival comparison between control and Osmacote application plots at Dahomey National Wildlife Refuge.

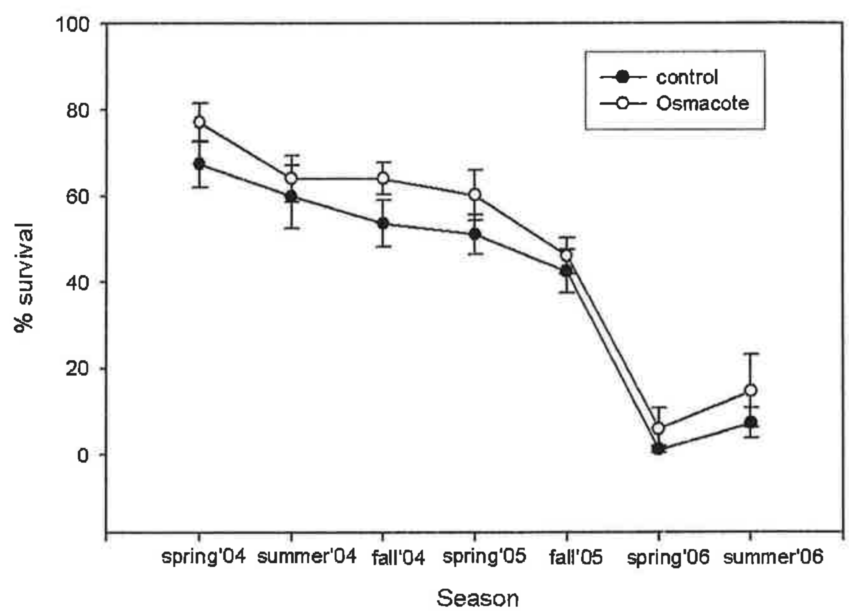


Figure 6. Total new shoot number comparison between control and Osmacote application plots at Dahomey National Wildlife Refuge.

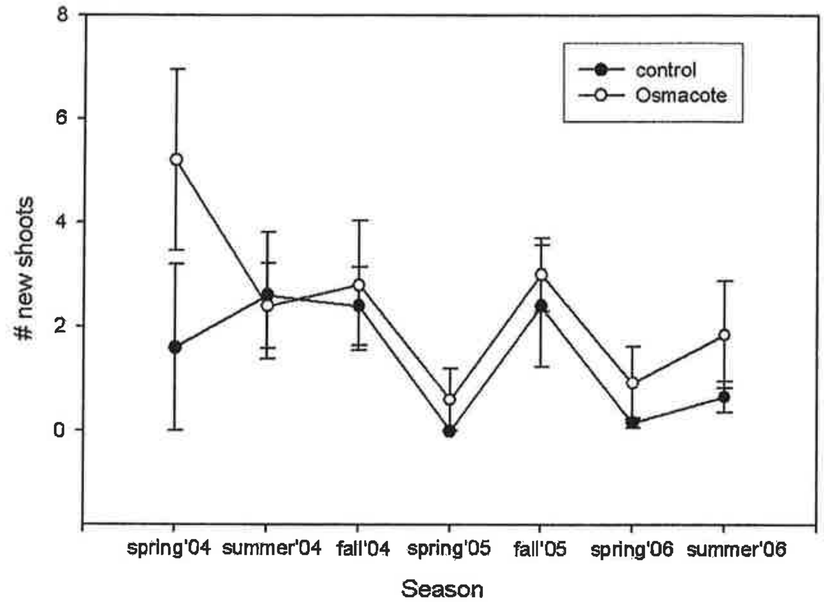


Figure 7. Total new shoot height (m) comparison between control and Osmacote application plots at Dahomey National Wildlife Refuge.

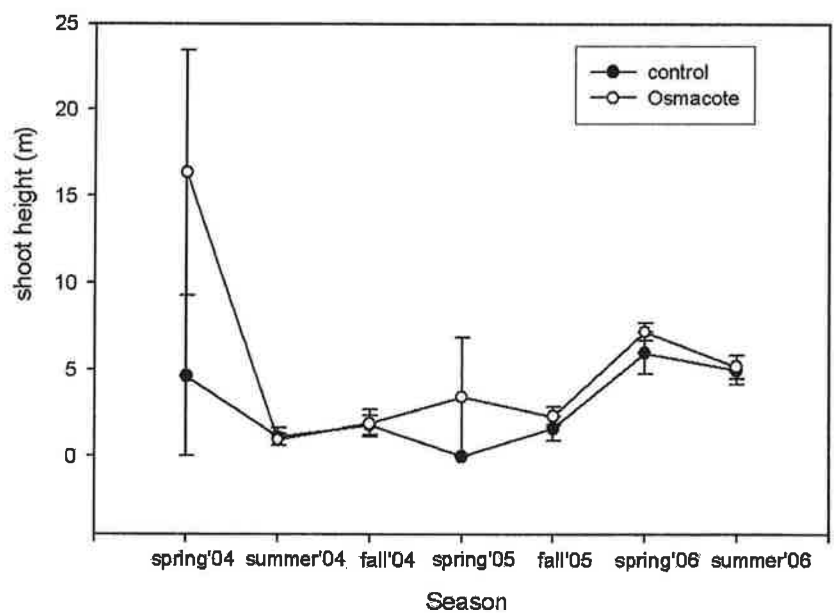


Figure 8. Total new shoot diameter (mm) comparison between control and Osmacote application plots at Dahomey National Wildlife Refuge.

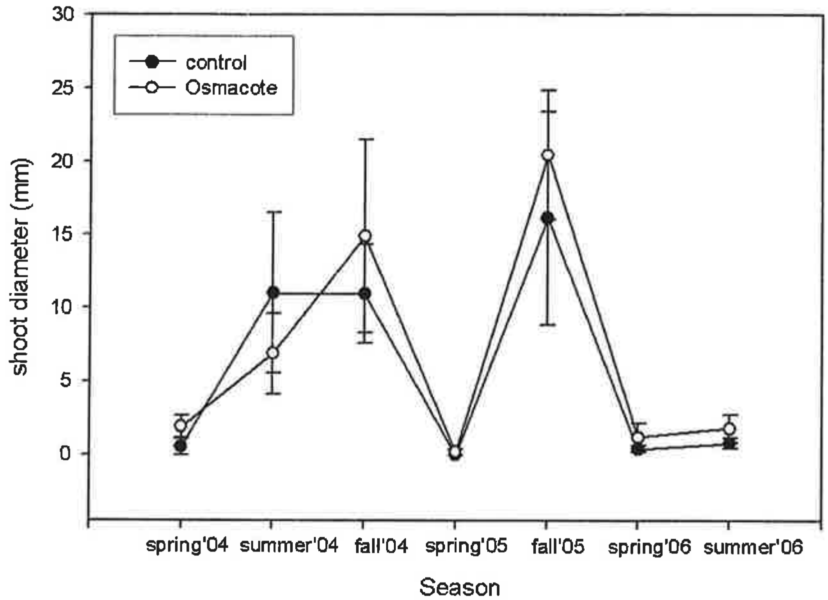


Table 2. Results of repeated measures ANOVA statistical analysis comparing % survival, number of new shoots, new shoot diameter (mm), new shoot height (m) of control plants to plants treated with Osmacote application.

Variable	Treatment(n=4)	Time	Mean	Std error	F	ρ
% Survival	Control	Spring '04	67.5000	5.37645	1.893	0.206
		Summer '04	60.0000	7.28869	0.206	0.662
		Fall '04	53.7500	5.44862	2.502	0.152
		Spring '05	51.2500	4.59279	1.501	0.255
		Fall '05	42.6000	5.06927	0.305	0.596
		Spring '06	1.2300	0.75574	1.034	0.339
		Summer '06	7.3140	3.53173	0.659	0.441
	Land Fabric	Spring '04	77.1420	4.49591		
		Summer '04	64.1080	5.36756		
		Fall '04	64.1080	3.63121		
		Spring '05	60.3580	5.84546		
		Fall '05	46.2500	4.23896		
		Spring '06	6.0600	4.69019		
		Summer '06	14.7320	8.43089		
Total ns #	Control	Spring '04	1.6000	1.60000	2.314	0.167
		Summer '04	2.6000	1.20830	0.019	0.894
		Fall '04	2.4000	0.74833	0.076	0.790
		Spring '05	0.0000	0.00000	1.000	0.347
		Fall '05	2.4000	1.16619	0.194	0.672
		Spring '06	0.1560	0.09600	1.165	0.312
		Summer '06	0.6540	0.30300	1.248	0.296
	Land Fabric	Spring '04	5.2000	1.74356		
		Summer '04	2.4000	0.81240		
		Fall '04	2.8000	1.24097		
		Spring '05	0.6000	0.60000		
		Fall '05	3.0000	0.70711		

		Spring '06	0.9240	0.70502		
		Summer '06	1.8520	1.02877		
Total ns dia(mm)	Control	Spring '04	0.5420	0.54200	2.091	0.186
		Summer '04	11.0500	5.46775	0.459	0.517
		Fall '04	10.9760	3.39742	0.279	0.611
		Spring '05	0.0000	0.00000	1.000	0.347
		Fall '05	16.1600	7.31409	0.256	0.626
		Spring '06	0.4000	0.24495	0.640	0.447
		Summer '06	0.8000	0.37417	0.926	0.364
	Land Fabric	Spring '04	1.8900	0.75848		
		Summer '04	6.8960	2.77749		
		Fall '04	14.9025	6.60620		
		Spring '05	0.2020	0.20200		
		Fall '05	20.4800	4.39708		
		Spring '06	1.2000	0.96954		
		Summer '06	1.8000	0.96954		
Total ns height (m)	Control	Spring '04	4.6460	4.64600	1.917	0.204
		Summer '04	1.1400	0.48620	0.086	0.777
		Fall '04	1.8080	0.56176	0.011	0.918
		Spring '05	0.0000	0.00000	1.000	0.347
		Fall '05	1.6200	0.70159	0.660	0.440
		Spring '06	6.0000	1.18322	0.878	0.376
		Summer '06	5.0000	0.83666	0.035	0.856
	Land Fabric	Spring '04	16.3760	7.08495		
		Summer '04	0.9700	0.31591		
		Fall '04	1.9100	0.78060		
		Spring '05	3.4440	3.44400		
		Fall '05	2.3500	0.56102		
		Spring '06	7.2000	0.48990		
		Summer '06	5.2000	0.66332		

Thinning Experiment

Methods

A site was set up at Dahomey National Wildlife Refuge containing two areas, one control and one with the canopy thinned by ~50%. In the fall of 2003, 20 plots in each area were established. In each plot, all stems of *Arundinaria gigantea* were classified as new shoot (<1 year old), culm (>1 year old), or dead. Stems were measured to the nearest 0.1 mm. Thinning was performed during the 2004 winter (Jan-Feb). Post-treatment data collection occurred in November 2004 and 2005. (Note: no data was collected in the fall of 2006 because plants within the site had flowered and could no longer be compared to the previous data).

Analysis

For stem density, stems within each treatment site were summed for analyses by stem type: 1) new shoot (< 1 year old), 2) culm (> 1 year old), and 3) dead. Stem diameters and heights were averaged for each treatment site prior to analyses. Hypotheses were: 1) there was no difference in the change of stem density or average stem diameter following thinning of the canopy, and 2) there was no change in the relative percentages of new shoots, culms, or dead stems following thinning.

Results & Interpretation

Hypothesis 1: Canopy thinning had no effect on the change of stem density or diameter.

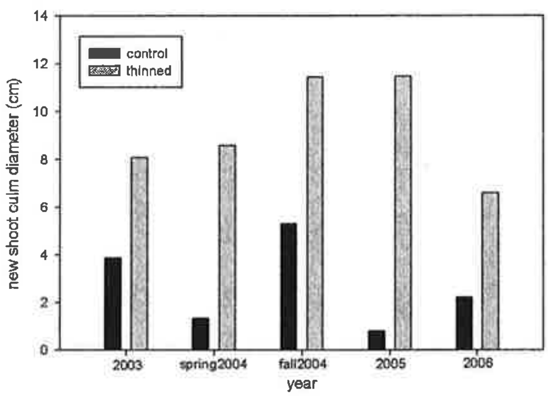
We were not able to analyze data based on a single site. Mean new shoot stem diameter, as well as stem height, did not indicate an effect due to canopy thinning (Figure 9a and 9b).

Hypothesis 2: Canopy thinning had no effect on the relative percentages of new shoots, culms, or dead stems.

We were not able to analyze data based on a single site. However the trends in data suggest thinned forests are increasing relative numbers of new shoots (Figure 10).

Figure 9a and 9b). Mean values for new shoot culm diameter and height did not indicate an effect due to canopy thinning.

a.



b.

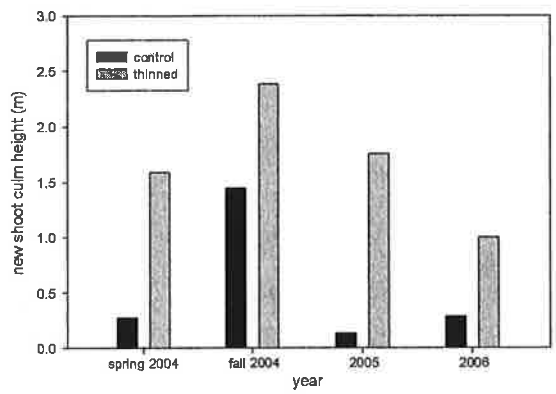
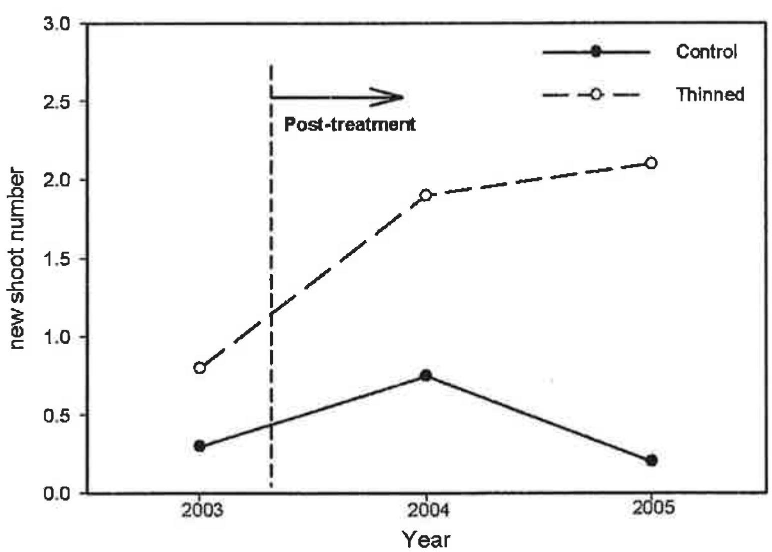


Figure 10. Following thinning treatment, the trend in data suggest thinned forests increase in relative number of new shoots when compared to unthinned forests.



Conclusion

Our expected results for the studies at DNWR were increased *A. gigantea* growth and survival with landscape fabric application, fertilization, and reduced forest canopy. However, our results did not support these expectations in regards to competition or fertilization.

Nutrient application was followed by frequent precipitation; potentially reducing fertilization effect on cane plots. Fertilization was increased to a minimum of three applications for the second year with the nutrient studies to insure treatment levels were higher.

We know *A. gigantea* seedlings have increased growth in full sun conditions and the thinning sites did reflect this same pattern. However, the number of sites for this study was too limited for definitive conclusions and canopy thinning will need to be repeated at alternate sites. Site conditions will be analyzed by measuring light levels, soil moisture and temperature. Soil cores will also be analyzed. Monitoring site conditions may give us insight into potential environmental conditions impacting the results.

LITERATURE CITED

Baer, S. G., Blair, J. M., Collins, S. L., & Knapp, A. K. 2004. Plant community responses to resource availability and heterogeneity during restoration. *Oecologia* 139:617-629.

Battaglia, L. L., Foré, S. A., & Sharitz, R. R. 2000. Seedling emergence, survival and size in relation to light and water availability in two bottomland hardwood species. *Journal of Ecology* 88:1041-1050.

Baskin, J. M., Chester, E. W., & Baskin, C. C. 1997. Special paper: forest vegetation of the Kentucky karst plain (Kentucky and Tennessee): review and synthesis. *Journal of the Torrey Botanical Society* 124:322-335.

Battaglia, L. L. & Sharitz, R. R. 2006. Responses of floodplain forest species to spatially condensed gradients: a test of the flood-shade tolerance tradeoff hypothesis. *Oecologia* 147:108-118.

Bond, E. M., & Chase, J. M. 2002. Biodiversity and ecosystem functioning at local and regional spatial scales. *Ecology Letters* 5:467-470.

Brantley, C. G. & Platt, S. G. 2001. Canebrake conservation in the southeastern United States. *Wildlife Society Bulletin* 29:1175-1181.

Brawn, J. D., Robinson, S. K., & Thompson III, F. R. 2001. The role of disturbance in the ecology and conservation of birds. *Annual Review of Ecological System* 32:251-276.

Breshears, D. D., Rich P. M., Barnes F. J., & Campbell, K. 1997. Overstory-imposed heterogeneity in solar radiation and soil moisture in a semiarid woodland. *Ecological Applications* 7:1201-1215.

Calderon, C. E. & Soderstrom, T. R. 1980. The genera of Bambusoideae (Poaceae) of the American continent: keys and comments. *Smithsonian Contributions to Botany* (Number 44). pp. 1-16. Smithsonian Institution, Washington, D. C.

Carpenter, S. R., Caraco, N. F., Correll, D. L., Howarth, R.W., Sharpley, A. N., & Smith, V. H. 1998. Nonpoint pollution of surface water with phosphorus and nitrogen. *Ecological Applications* 8:559–568.

Caplenor, D. 1968. Forest composition on loessial and non-loessial soils in west-central Mississippi. *Ecology* 49:322-331.

Cavender-Bares, J., Kitajima, K., & Bazzaz, F. A. 2004. Multiple trait associations in relation to habitat differentiation among 17 Floridian oak species. *Ecological Monographs* 74:635-662.

Cirtain, M.C., Franklin, J. R., & Franklin, S. B. 2003. Effects of nutrients and shading on *Arundinaria gigantea* (Walt.) Walt. Ex Muhl. seedling growth. *Tenth Annual Symposium on the Natural History of the Lower Cumberland and Tennessee Rivers*. pp. 49-56. Austin Peay State University Center for Field Biology, Clarksville, TN.

Cirtain, M.C., Franklin, S. B., & Pezeshki, S. R. 2004. Effects of nitrogen and moisture regimes on *Arundinaria gigantea* (Walt.) Walt. Ex Muhl. seedling growth. *Natural Areas Journal* 24:251-257.

Clinton, B. D., Boring, L. R., & Swank, W. T. 1994. Regeneration patterns in canopy gaps of mixed-oak forests of the Southern Appalachians: Influences of topographic position and evergreen understory. *American Midland Naturalist* 132:308-319.

Clinton, B. D. 2003. Light, temperature, and soil moisture responses to elevation, evergreen understory, and small canopy gaps in the southern Appalachians. *Forest Ecology and Management* 186:243-255.

Conover, A. 1994. A new world comes to life, discovered in a stalk of bamboo. *Smithsonian Magazine* (October): 120-129

Dattilo, A. J. & Rhoades, C. C. 2005. Establishment of the woody grass *Arundinaria gigantea* for riparian restoration. *Restoration Ecology* 13:616-622.

Fickle, J. E. 2001. *Mississippi forests and forestry*. University Press of Mississippi, Jackson, MS.

Fitter, A. H. & Hay, R. K. M. 2002. *Environmental Physiology of Plants*. Academic Press, San Diego, CA.

Fralish, J. S. & Franklin, S. B. 2002. *Taxonomy and ecology of woody plants in North American forests (excluding Mexico)*. John Wiley & Sons, New York.

Gilliam, F. S. & Christensen, N. L. 1986. Herb-layer response to burning in the pine flatwoods of the lower coastal plain of South Carolina. *Bulletin of the Torrey Botanical Club*. 113:42-45.

Graves, G. R. 2001. Factors governing the distribution of Swainson's warbler along a hydrological gradient in the Great Dismal Swamp. *The Auk* 118(3):650-664.

Griscom, B. W. & Ashton, P. M. S. 2003. Bamboo control of forest succession: *Guadua sarcocarpa* in southeastern Peru. *Forest Ecology and Management* 175:445-454.

Godman, R. M. & Tubbs, C. H. 1973. Establishing even-age northern hardwood regeneration by the shelterwood method-a preliminary guide. USDA Forest Service, North Central Forest Experiment Station, St. Paul, MN, Research Paper NC-99.

Hughes, R. H. 1951. Observations of cane (Arundinaria) flowers, seed, and seedlings in the North Carolina coastal plain. *Bulletin of the Torrey Botanical Club* 78:113-121.

Hughes, R.H. 1996. Fire ecology of canebrakes. *Proceedings of the Fifth Annual Tall Timbers Fire Ecology Conference*, March 24-25, 1966, Minneapolis, MN.

Jordan, R. A. & Hartman, J. M. 1996. Effects of canopy opening on recruitment in *Clethra alnifolia* L. (Clethraceae) populations in central New Jersey wetland forests. *Bulletin of the Torrey Botanical Club* 123:286-294.

Judziewicz, E. J., Clark, L. G., Londono, X., & Stern, M. J. 1999. *American Bamboos*. Smithsonian Institution Press, Washington, D. C.

Kozlowski, T. T. & Pallardy, S. G. (1997) *Physiology of Woody Plants.* 2nd Edition. Academic Press, San Diego, CA.

Lei, T. T. & Koile, T. 1998. Functional leaf phenotypes for shaded and open environments of a dominant dwarf bamboo (*Sasa senanensis*) in northern Japan. *International Journal of Plant Science* 159:812-820.

McClure, F. A. 1973. Genera of Bamboos native to the New World (*Gramineae: Bambusoideae*). Ed. T. R. Soderstrom. *Smithsonian Contributions to Botany* (Number 9). pp. 21-46. Washington, D. C.

Nelson, J.C. 1997. Presettlement vegetation patterns along the 5th principle meridian, Missouri Territory, 1815. *American Midland Naturalist.*

Noss, R. F., Laroe III, E. T., & Scott, J.M. 1995. Endangered ecosystems of the United States: a preliminary assessment of loss and degradation. Untied States Department of Interior, National Biological Service, Biological Report 28, Washington, D.C.

Pages, J-P. & Michalet, R. 2003. A test of the indirect facilitation model in a temperate hardwood forest of the northern French Alps. *Journal of Ecology* 91:932-940.

Platt, S.G. & Brantley, C.G. 1997. Canebrakes: An ecological and historical perspective. *Castanea* 62(1):8-21.

Platt, S.G., Brantley, C.G., & Rainwater, T.R. 2001. Canebrake fauna: wildlife diversity in a critically endangered ecosystem. *The Journal of the Elisha Mitchell Scientific Society* 117(1):1-19.

Reich, P. B., Buschena, C., Tjoelker, M. G., Wrage, K., Knops, J., Tilman, D., & Machado, J. L. 2003. Variation in growth rate and ecophysiology among 34 grassland and savanna species under contrasting N supply: a test of functional group differences. *New Phytologist* 157:617-631.

Reid, D. G., Taylor, A. H., Jinchu, H., & Zisheng, Q. 1991. Environmental influences on bamboo *Bashania fangiana* growth for Giant Panda conservation. *Journal of Applied Ecology* 28:855-868.

Remson, J.V. 1986. Seed bank dynamics in a southern riverine swamp. *American Journal of Botany* 73:1022-1030.

Saitoh, T., Seiwa, K., & Nishiwaki, A. 2002. Importance of physiological integration of dwarf bamboo to persistence in forest understory: a field experiment. *Journal of Ecology* 90:78-85.

Schoonover, J. E., Williard, K. W. J., Zaczek, J. J., Mangun, J. C., & Carver, A. D. 2006. Agricultural sediment reduction by giant cane and forest riparian buffers. *Water, Air, and Soil Pollution* 169:303-315.

Schoonover, J. E. & Williard, K. W. J. 2003. Ground water nitrate reduction in giant cane and forest riparian buffer zones. *Journal of the American Water Resources Association* 39:347-354.

Stuefer, J. F., During, H. J., & de Kroon, H. 1994. High benefits of clonal integration in two stoloniferous species, in response to heterogeneous light environments. *Journal of Ecology* 82:511-518.

Thomas, B. G., Wiggins, E. P., & Clawson, R. L. 1996. Habitat selection and breeding status of Swainson's warbler in southern Missouri. *Journal of Wildlife Management.* 60(3):611-616

Tilman, D. 2004. Niche tradeoffs, neutrality, and community structure: A stochastic theory of resource competition, invasion, and community assembly. *Proceedings of the National Academy of Science* 101:10854-10861.

Veblen, T. T., Veblen, A. T., & Schlegel, F. M. 1979. Understorey patterns in mixed evergreen-deciduous *Nothofagus* forests in Chile. *Journal of Ecology* 67:809-823.

Widmer, Y. 1998. Pattern and performance of understory bamboos (*Chusques* spp.) under different canopy closures in old-growth oak forests in Costa Rica. *Biotropica* 30:400-415.

Zaczek, J. J., Sexton R. L., Williard, K. W. J., & Groninger, J. W. 2004. Propagation of giant cane *(Arundinaria gigantea)* for riparian habitat restoration. USDA Forest Service Proceedings RMRS-P-33.